ENGINES AND COMPRESSORS

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of applicant's prior application Ser. No. 240,394, filed Apr. 3, 1972, and now abandoned and relates to engines, motors and pumps, hereinafter referred to as "machines" for brevity, in which fluid is passed to the machine at one pressure and fluid is passed out of the machine at another pressure, the change in fluid pressure being reflected in power generated or used by the machine.

Machines have previously been proposed in which a crankpin of a crankshaft is eccentrically received in a disc received in an aperture of a yoke or rod to the opposite ends of which pistons are attached for reciprocating movement in cylinders. The eccentricity of the axis of the disc relative to the crankpin axis is equal to the eccentricity of the latter relative to the crankshaft axis. Such machines are unworkable since when the crankshaft has been turned (e.g. by gas forces acting on the piston) until the piston has completed 90° of its stroke from top dead center, the axis of the disc and the axis of the crankshaft are co-linear, and no further rotational movement of the crankshaft with corresponding linear reciprocating movement of the piston(s) can occur, unless some means are provided for causing a relative rolling movement of the disc and a corresponding linear movement of the piston(s) whereby the co-linearity of the disc axis and crankshaft axis is disturbed.

Machines incorporating such means for causing relative rotational movement of the disc and corresponding linear movement of the pistons have been proposed, the said means being a peg, gear or gear train providing a resisting force on the disc parallel to, but offset from, the line of action of the force exerted from the piston so that at positions of concentricity of the disc and crankshaft, a moment is created by the action of the force exerted by the piston and the opposed resisting force exerted by the gear thereby causing the disc to rotate about the crankpin so that the disc and crankshaft are no longer coaxial. The resistance of the gear or gear train is provided by meshing with gearing provided on the crankcase or frame of the machine or by meshing with gearing on the crankshaft. The resistance manifests itself as a torque in the machine frame or crankcase or a counter-torque in the crankshaft. The gear which engages the disc must be outside the volume swept by the yoke to avoid fouling, and in consequence, the crankpin is axially lengthened to accommodate the additional axial length of the gear.

Although primary balance of this type of machine is obtainable by employing an array of pairs of cylinders which are symmetrical about the crankshaft axis, a major problem in machines of this type is to provide a satisfactory relationship between the crankpin throw, the crankpin diameter and the diameter of the discs if high performance is to be attained without unacceptable stressing of the dynamically stressed parts, and it is highly desirable to minimize, as far as possible, the crankpin diameter for a required bending stiffness: this desirable optimization can only be achieved by empolying the shortest possible crankpin.

Among the objects of the present invention are the mitigation of the foregoing disadvantages and a reduction in the cost of large-scale manufacture of such machines by avoiding the use of gear trains in the ma-

chines and to improve the overall efficiency of such machines.

Another object of the present invention is to provide an improved mechanical arrangement for the taking up of the side forces through the use of a wear shim mounted on the piston thereby permitting the design of maximum stiffness piston connecting yokes. The wear shim is preferably made of thin hard metal sufficiently flexible to allow a wedge of lubricant to form between the shim and cylinder walls as the piston reciprocates.

The present invention provides a machine (as hereinbefore defined) comprising a frame, a crankshaft rotatably mounted in the frame, at least one plurality of pairs of cylinders attached to the frame, the cylinders in each pair being disposed on opposite sides of the axis of the crankshaft and the pairs of cylinders being angularly and axially separated around the crankshaft axis, means for allowing fluid to pass into each cylinder at one pressure and for allowing fluid to pass out of each cylinder at another pressure, the crankshaft having one crankpin for the or each plurality of pairs of cylinders, the or each crankpin having an axis which is eccentric relative to the crankshaft axis, a plurality of discs equal in number to the number of pairs of cylinders and each disc being rotatably mounted on one of the crankpins between the cylinders of a respective cylinder pair with its geometric axis having an eccentricity relative to the crankpin axis equal to the eccentricity of the crankpin axis relative to the crankshaft axis, the geometric axes of the discs on the or each crankpin having a relative angular separation which is twice the relative angular separation of their respective cylinder pairs, adjacent discs being in contact with each other over areas bounded between their superimposed peripheries (as viewed in directions parallel to the crankshaft axis) and rigidly connected to each other within said areas whereby all the discs on a common crankpin rotate together, the periphery of each disc being adapted to take a bearing load, and each disc being received in a bearing apertures of a rigid yoke which extends perpendicularly to the crankshaft axis and symmetrically on both sides of the disc, there being in each cylinder a piston connected to an end of the respective yoke, the piston having a substantially fluid-tight seal with the respective cylinder, there being no gear or gear-train connection between any one of the discs and any part of the frame or the crankshaft.

Although rolling bearing elements may be located between the surfaces of the yokes and discs, and the surfaces of the discs and crankpin(s), it is preferred to employ plain bearings in order to minimize the overall dimensions and increase the stiffness of the machine.

The yokes and discs are preferbly formed from a light alloy, and there may be an insert of thin sheet resilient wear-resistant metal such as hardened and ground sheet steel strip tightly received around the aperture of each yoke to serve as a bearing. The thickness of the strip should be a very small proportion of the diameter of the bearing aperture of the yoke, e.g. for a 3-inch yoke bearing aperture, a bearing strip having a thickness of about 0.02 inch would be satisfactory. Methods of forming such bearing strip inserts in apertures for other purposes are described in British patent specifications 1,237,962 and 1,244,800.

Lubrication of the rubbing surfaces of the machines is preferably provided by oilways extending from the bearings of the crankshaft into the crankpin and radially to the surface of the crankpin. Oil distribution may